

FINAL REPORT

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SPICE BREEDING AND AGRONOMIC RESEARCH

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Spice Breeding and Agronomic Research

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Final Report
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F. A. Holm
And

A. E. Slinkard

Crop Development Centre
University of Saskatchewan
51 Campus Drive
Saskatoon, SK S7N 5A8
Ph: (306) 966-8195 and 966-4978

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Executive Summary

In 1977, selected accessions of coriander, annual caraway, biennial caraway, anise, dill and fenugreek were available from a previous project. Attempts were made to increase them in 1998 and 1999. Due to severe aster yellows phytoplasma infection in 1997, these populations were replanted 1998 and 1999, but the dry spring of 1999 resulted in the loss of the annual caraway, the biennial caraway and the anise. Consequently, they were dropped from the program and only coriander, dill and fenugreek were continued in 2000 and 2001. Fenugreek results will be reported in a separate report.

Advanced selections of two populations of dill were yield tested in 2001 and the highest yielding lines from the better population will be bulked as pre-Breeder seed for the production of Breeder seed of an improved variety in 2002.

Advanced selections of small-seeded coriander and medium large-seeded coriander were yield tested in 2001 and will be re-tested in 2002. A coriander population with high essential oil concentration has been developed, but it is highly variable. In 2002, 100 plants should be selected, increased as miniplots in 2003 and the best miniplots bulked to produce Breeder seed of a new variety high in essential oil in 2004.

Results from the coriander breeding program indicate that plant height, maturity, 1000-fruit weight, percentage essential oil, percentage linalool, percentage fixed oil and percentage petroselinic acid have medium to high heritabilities in the populations under study. Thus, selection based on a progeny test of an individual plant for any one of these traits will be successful, provided that the plant breeder uses remnant seed of the selected lines for random cross-pollination in a completely isolated plot. These results may very well apply to the other species in the Apiaceae (carrot family), assuming that genetic variability is present, and proper isolation is maintained in the succeeding generations.

In 2001, 50 individual plants of anise were selected and will be grown as miniplots in 2002. They will be evaluated for essential oil concentration and the best ones bulked for production of Breeder seed in 2003.

Results from four years of research on dormant planting of coriander, annual caraway, anise, dill and ajowan indicate that dormant planting of coriander has a high probability of success and that this practice should be widely promoted in Saskatchewan. Results with dormant seeding of dill suggest that it likely would be successful in most years, if the seeding rate was doubled or tripled. Results of dormant seeding of annual caraway and anise were not so favorable and this practice can not be recommended for these two species. In practice, early April seeding has been successful for anise and biennial caraway. Very little annual caraway is grown due to its low percentage essential oil, relative to biennial caraway.

Results of a seed priming experiment with anise indicate that this practice was successful in improving seed quality. Anise stands often are thin and irregular. This results in variable maturity from plant to plant because of the strongly indeterminate flowering habit of anise. An early frost can severely damage the late maturing seed, resulting in poor quality anise seed. The anise seeds were primed by placing them in aerated water at room temperature (about 20 C) for 24 to 36 hours and then drying them down to ambient seed moisture levels before seeding. Planting of primed anise seed produced a denser stand and more uniform maturity across the field, resulting in higher quality seed. In a year with drought stress during seed germination and emergence, the primed seed also produced seedlings that emerged 3-5 days earlier and produced a much denser stand than seedlings from the non-primed seed. Unfortunately, seed yield did not increase over that of the non-primed check, probably because of the severe drought that resulted in anise maturing a month earlier than normal. Priming of anise seed improves the quality and uniformity of the anise seed, but can producers be bothered with this extra fuss and bother?

Breeder seed of two new varieties of fenugreek will be produced in 2002, as part of another project

Spice Breeding and Agronomic Research

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Technical Report

The United States market for spices and herbs now exceeds \$400 million and is projected to grow by 5% per year. This growth in market is based on growth of high fibre, low fat, low cholesterol, low sodium and sugar-free processed foods. The trend is toward development of complex blends of spices and flavorings to compensate for use of fat substitutes and high fibre ingredients in baked goods, snacks and modified dairy products. Stability of flavors is needed for microwave cooking and the maintenance of spicy flavors in extruded snacks, cereals, frozen foods and dry beverage mixes.

In 2001, over 40,000 acres of five spice crops (coriander, caraway, anise, dill and fenugreek) were grown in Saskatchewan and acreage is expected to increase in the future. For example, the acreage of coriander increased from 9000 acres in 1996 to 20,000 acres in 2000 (only about 10,000 acres in 2001 due to the over production in 2000). Thus, production of these spice crops is increasing rapidly. Value-added processing (distillation) of seed or foliage (dill and coriander) for essential oil will add materially to the value of these crops. Several distillation plants are available in Saskatchewan for use on these crops. Recently, a process for continuous crushing and steam distillation has been developed to extract essential oil from seed of these spices with a high level of efficiency.

Almost two-thirds of the United States requirement for spices and flavorings is imported from countries where quality standards are almost non-existent. Currently, the Canadian cultivars of these five spice crops are of unknown origin and include a diverse group of lines introduced over the years. As such, they are of unknown quality and include many low yielding, unadapted land races. The major exception is fenugreek where AC Amber and CDC Quatro have been released as improved cultivars. In 1999, two coriander varieties were released by the Crop Development Centre, CDC Major (large fruited) and CDC Minor (small fruited). Additional efforts must be made to develop high quality and high yield cultivars of these spice crops for Saskatchewan. Then, Saskatchewan can readily establish itself as a dependable source of known, high quality seed of coriander, caraway, dill, anise and fenugreek. This also means that a package of agronomic practices must be developed for these five spice crops, so those Saskatchewan producers can consistently produce economic yields of these high quality cultivars.

Objectives:

The objectives of this project are to:

1. Develop high yielding, high quality cultivars of coriander, annual caraway, anise, dill and fenugreek.
2. Develop a package of agronomic practices for the production of economic yields of these improved spice crop cultivars.

Activities

Breeding and Management by Crop – The type and concentration of essential oil and the percentage fixed oils and earlier maturity are the traits of primary importance in all of these crops, except for earlier maturity in biennial caraway. Yield trials consisted of 4 rows 30 cm apart and 4 m long, replicated 3 or 4 times at Saskatoon. All oil quality analyses were done in the lab in the Agriculture Building.

1. Coriander (*Coriandrum sativum* L.)

CDC Minor small-seeded coriander and CDC Major medium large-seeded coriander were released from this program in 1999 and enough pedigreed seed has been produced to plant at least 25 % of the anticipated coriander acreage in 2002.

Breeding Studies: Testing continued on the most promising coriander lines. Agronomic and quality data for the small-fruited lines are presented in Table 1. Most lines out-yielded the small-fruited check variety CDC Minor. Ten of the 15 lines had an essential oil concentration over 1 % and seven of them were higher than the small-fruited check variety CDC Minor. Ames 25168 (Am 68) had an unusually high percentage essential oil: 1.79 %, relative to 0.95 % for CDC Major and 1.19 % for CDC Minor in 2000, and 1.23 %, relative to 0.74 % for CDC Major and 1.09 % for CDC Minor in 2001. Percentage essential oil in Ames 25168 was consistently high in all trials, suggesting that this trait is highly heritable. Highly heritable traits can be successfully selected for on an individual plant basis, provided the material is kept properly isolated from unselected material.

One hundred individual plants of small-fruited coriander were reselected from CDC Minor in 1999, increased in miniplots in 2000 and 24 of the best ones were planted in a replicated yield trial at Saskatoon in 2001. Data on agronomic and quality traits are presented in Table 2. Again, most of the lines out-yielded the small-fruited check variety CDC Minor. However, only three lines had an essential oil concentration over 1 %. Apparently, selection for yield was effective, and percentage essential oil remained the same. The highest yielding small-fruited lines with high percentage essential oil from Tables 1 and 2 will be re-evaluated in comparison with the small-fruited check cultivar CDC Minor in 2002.

One hundred individual plants of medium large-fruited coriander were reselected from CDC Major in 1999, increased in miniplots in 2000 and 24 of the best ones were planted in a replicated yield trial at Saskatoon in 2001. Data on agronomic and quality traits are presented in Table 3. Again, most of the lines out-yielded the medium large-fruited check variety CDC Major. The highest yielding lines will be re-tested in 2002.

Table 1. Agronomic and quality data for selected small-fruited lines of coriander (Yield Trial 1) at Saskatoon in 2001.

Line	Seed yield (kg/ha)	Height (cm)	Days to flower	Days to mature	1000-seed weight (g)	Essential oil (%)	Linalool (%) in EO	Petroselinic acid (%) in fixed oil)
Am 73	1974	72	53	106	9.17	0.76	70.1	68.6
LS-5	1797	64	55	106	9.78	0.98	65.1	67.1
Major	1788	74	57	105	10.70	0.74	65.9	67.8
LS-10	1736	70	54	106	10.07	0.85	64.0	67.1
Am 70	1695	60	56	106	9.62	0.57	69.7	68.8
Am 69	1693	72	57	106	9.42	0.62	69.7	69.2
LS-1	1680	60	60	108	8.42	0.84	67.3	67.6
LS-3	1677	61	53	105	9.51	0.97	65.7	66.8
LS-9	1662	74	58	106	9.33	0.93	65.6	66.8
SS-6	1633	70	54	105	7.99	1.16	68.4	63.5
Am 72	1620	68	58	106	9.26	0.69	67.2	68.2
Am 76	1615	65	53	105	9.92	0.71	65.3	68.9
GH-1	1602	70	55	105	9.41	1.09	68.0	66.6
SS-3	1601	66	59	106	7.88	1.13	71.3	64.3
LS-6	1594	71	53	107	9.21	0.92	66.8	68.2
C-81	1585	64	59	105	8.27	1.16	68.4	65.6
SS-8	1538	68	56	106	8.94	1.08	69.0	65.4
LS-7	1534	67	59	106	9.23	0.94	69.6	67.6
Am 67	1533	68	56	106	8.75	0.67	65.2	69.3
SS-7	1498	65	59	105	7.79	1.10	69.5	62.9
SS-9	1492	65	56	105	8.20	1.12	72.0	64.2
Am 68	1480	71	55	105	9.06	1.23	68.7	66.8
LS-2	1472	72	56	105	8.65	1.02	66.6	67.9
Minor	1469	70	58	105	8.71	1.09	68.0	66.1
SS-2	1466	68	55	106	8.34	1.21	69.3	64.9
MEAN	1618	68	56	106	9.03	0.94	67.8	66.8
LSD (0.05)	231	--	--	--	--	--	--	--

Table 2. Agronomic and quality data for 24 selected plant progenies from the small-fruited coriander cultivar CDC Minor (Coriander Yield Trial 2) at Saskatoon in 2001.

Line	Seed yield (kg/ha)	Height (cm)	Days to flower	Days to mature	1000-seed weight (g)	Essential oil (%)	Linalool (%) in EO	Petroselinic acid (%) in fixed oil)
MP-27	2265	74	57	107	8.9	1.12	70.9	68.0
MP-3	2253	72	58	108	9.3	0.81	67.6	67.7
MP-31	2172	83	60	107	10.1	0.81	70.2	68.0
MP-6	2162	73	58	108	9.9	0.81	64.7	67.6
MP-28	2136	72	60	109	9.4	0.75	66.8	67.3
MP-7	2125	74	56	106	8.8	0.98	72.7	67.6
MP-23	2122	70	57	106	8.4	0.68	73.4	68.4
MP-24	2091	73	59	108	9.2	1.01	71.9	67.6
MP-38	2088	67	59	107	9.2	0.95	71.4	67.4
MP-17	2063	72	54	106	10.4	0.81	72.1	68.1
MP-10	2049	67	56	107	9.1	0.89	68.1	68.5
MP-22	2048	70	56	108	8.1	0.83	72.7	66.6
MP-37	2030	78	57	106	8.7	0.90	68.2	68.0
MP-30	2022	73	55	106	9.1	0.84	66.9	67.7
MP-25	1988	76	59	108	8.9	0.96	70.5	67.4
MP-14	1976	72	55	106	9.2	0.85	71.4	68.5
MP-16	1968	65	58	108	10.1	0.95	62.1	67.8
MP-19	1956	68	55	107	9.4	1.01	68.2	67.9
MP-36	1946	70	58	106	8.9	0.94	71.6	67.7
MP-32	1945	70	56	107	8.2	1.06	68.0	66.3
MP-26	1918	72	56	209	10.0	0.90	68.6	67.0
Minor	1902	68	57	108	8.6	1.11	69.8	66.5
MP-2	1849	83	58	106	9.6	0.89	69.5	67.7
MP-1	1801	70	59	107	9.3	0.81	67.6	67.7
MP-34	1766	70	55	109	8.3	1.11	65.2	66.0
MEAN	2026	73	56	107	9.2	0.91	69.0	7.6
LSD (0.05)	138	--	--	--	--	--	--	--

Table 3. Agronomic and quality data for 24 selected plant progenies from the medium large-seeded coriander variety CDC Major (Coriander Yield Trial 2) at Saskatoon in 2001.

Line	Seed yield (kg/ha)	Height (cm)	Days to flower	Days to mature	1000-seed weight (g)	Essential oil (%)	Linalool (%) in EO	Petroselinic acid (%) in fixed oil)
MP-3	2735	72	56	105	10.2	0.78	69.8	68.7
MP-22	2700	68	60	107	11.3	0.80	70.2	68.3
MP-19	2571	67	58	106	10.1	0.89	64.1	68.6
MP-8	2564	65	60	106	9.0	0.71	66.6	66.4
MP-25	2557	69	59	106	10.2	0.72	63.1	66.5
MP-29	2542	72	58	106	10.1	0.93	67.4	68.7
MP-4	2530	64	55	106	10.8	0.71	65.4	68.5
MP-15	2518	74	56	105	11.4	0.73	64.3	68.1
MP-12	2477	62	58	106	9.9	0.82	67.1	67.3
MP-16	2470	68	56	106	10.7	0.71	61.7	67.6
MP-27	2462	80	60	108	11.6	0.63	68.2	68.5
MP-7	2437	77	58	105	10.4	0.77	61.3	67.3
MP-26	2423	62	59	106	10.1	0.80	70.4	67.6
MP-18	2403	65	60	106	10.0	0.89	64.4	67.6
MP-13	2371	70	59	105	10.7	0.79	72.0	66.7
MP-5	2336	62	60	107	10.3	0.91	61.7	68.5
MP-1	2325	62	60	106	12.4	0.77	61.3	67.3
MP-24	2309	62	60	107	9.4	0.82	69.7	67.9
MP-20	2285	69	60	107	11.7	0.73	67.3	66.9
Major	2251	67	59	106	10.9	0.82	63.5	67.3
MP-14	2161	72	56	105	11.6	0.69	62.3	67.5
MP-9	2116	64	60	106	10.0	0.76	68.3	68.0
MP-2	2098	67	58	107	11.4	0.73	66.6	67.7
MP-21	2080	74	58	106	10.2	0.85	69.5	67.5
MP-28	1974	70	59	109	10.5	0.81	65.2	67.8
MEAN	2385	68	58	1206	10.6	0.78	66.06	67.7
LSD (0.05)	490	--	--	--	--	--	--	--

Thirty-six lines of coriander were increased in non-replicated miniplots at Saskatoon in 1999 and were grown in a replicated yield trial at Saskatoon in 2000. Quality data were collected on all 36 lines in both years (see the 1999 report for the 1999 data and the 2000 report for the 2000 data). The variation in 1000-fruit weight, percentage essential oil, percentage linalool and percentage petroselenic acid was meaningful in both years.

Accordingly, correlations between years were calculated for these traits. Correlations between years measure the repeatability of that trait, and provide an estimate of heritability or how successful selection for that trait will be in that population. A highly heritable trait can be successfully selected for on an individual plant or an individual plot basis.

The between year correlations (heritabilities) are as follows:

1000-fruit weight	0.87
Percentage essential oil	0.93
Percentage linalool	0.83
Percentage petroselenic acid	0.83

These correlations indicate that these four traits are highly heritable and that selection of individual plants for any one of these traits would be successful, assuming that proper isolation from unselected plants was maintained in the next generations. However, it is unlikely that one could successfully select for more than two of these traits in a specific breeding program.

The correlation between 1000-fruit weight and percentage essential oil was calculated for the replicated yield trial in 2000. The correlation was -0.48 , indicating a negative relationship between seed weight and percentage essential oil, as noted earlier. The coefficient of determination (correlation²) indicated that only 22 % of the variation in percentage essential oil was related to variation in fruit weight. Thus, selection for low fruit weight would not necessarily result in a higher percentage essential oil or vice-versa.

A few generalizations can be made about significant numbers for the various quality traits:

1. One decimal is adequate for 1000-fruit weight, percentage linalool and all of the fixed oils because of either the low values or the low variation or both.
2. Two decimals are required only for percentage essential oil.

A few generalizations can also be made about replication:

1. Four replications are necessary for traits of low heritability, such as yield.
2. Two replications (in duplicate) are adequate for the various quality traits with medium high heritability, such as 1000-seed weight, percentage fixed oil and its major component (e.g., percentage petroselenic acid in coriander), percentage essential oil and its major component (e.g., percentage linalool in coriander).

3. One observation in a progeny test is adequate for highly heritable traits, such as plant height, days to flower and days to mature, assuming a normal competitive stand in every plot.

Dormant Planting Studies: Dormant planting (in late October) of coriander has been successful every year tested except in the fall of 2001, when the exceptionally dry spring of 2002 prevented emergence, even of some of the spring-planted coriander. However, the frequency of success was high enough to make this a recommended practice, giving the farmers another option.

2. Annual caraway (*Carum carvi* L.)

Breeding Studies: Two lines of annual caraway were planted in 1997, but a severe infestation with aster yellows prevented seed production. This was repeated in 1998 and 100 plants were selected from each line and increased in 1998. Seed was replanted in 1999 and again in 2000, but the stands failed to establish in both years, after which breeding efforts were terminated due to lack of progress and the short time frame of this project.

Dormant Planting Studies: Two lines of annual caraway, Karzo and Moran, were dormant planted (in late October) of 1997, 1998, 1999 and 2000. However, seed was harvested in only one year due to poor stands and this practice cannot be recommended for Saskatchewan. An alternative practice may be priming the seed and planting very early in the spring (see Priming Studies under anise).

3. Anise (*Pimpinella anisum* L.)

Breeding Studies: Two lines of anise were planted in the spring of 1997. At harvest time 100 individual plants were selected from each line and increased in 1998 and 1999. Seed was replanted in 1999 and again in 2000, but the stands failed to establish in both years. Subsequently, the breeding efforts were terminated due to lack of progress and the short time frame of this project. However, 100 plants were harvested and a progeny test will be conducted in 2002 to determine the range in variability for date of flowering.

Dormant Planting Studies: Two lines of anise were dormant planted (in late October) of 1997, 1998, 1999 and 2000. Unfortunately, seed was harvested in only one year due to poor stands and this practice cannot be recommended for Saskatchewan. An alternative practice may be priming the seed and planting very early in the spring (see below).

Priming Studies: This summary illustrates how the results from a two-year collaborative research project at Saskatoon SK and Brooks AB can be applied to practical situations to the benefit of spice producers.

Anise is a late maturing crop in western Canada. Anise plants have a strongly indeterminate growth habit and, under favorable growing conditions, they will continue producing another umbel (flowering head) from the node just below the previous umbel. Each successive umbel is smaller and later maturing than the one before it. In addition, the fruits (each containing two seeds) in these later maturing umbels are smaller and are often damaged by an early fall frost.

The Problem:

Anise seeds are planted shallowly into moist soil in the early spring, but 3-4 weeks are often required for seed germination and emergence of the tiny seedlings. If the surface one inch (2.5 cm) or so of the soil dries out in this time, a thin irregular stand often results. Gaps in the stand stimulate late production of umbels and provide an opening for weeds, both of which reduce quality of the anise crop.

The Solution:

The quality of anise seed produced in western Canada can be improved by either:

1. Increasing stand uniformity by increasing the percentage of seeds that develop into established seedlings (a higher planting rate may help in some situations). A uniform stand will ripen more evenly and result in a higher quality crop of anise.
2. Reducing the time required for the anise seed to germinate and the seedlings to become successfully established. This is particularly critical in years when the surface one inch (or so) of soil dries out between planting the seeds and establishment of the tiny seedlings. Under these conditions, a longer time between planting and stand establishment results in thinner stand, variable maturity and a lower quality crop of anise.

Action Required:

Priming the seeds of anise with water will result in a more uniform stand by increasing the percentage emergence and, in years with drought stress between planting and successful stand establishment, the time to emergence can be reduced by 3-5 days.

The Process of Priming:

Priming can be accomplished by soaking the anise seeds in aerated water at room temperature for 24-36 hours. A gentle bubbling from an air compressor will supply an adequate supply of oxygen for a large container of water. Porous bags of anise seeds, tied loosely to allow for expansion, can be submerged in the container of aerated water near room temperature (68-72 F (18-20C) in your garage or shop for 24-36 hours. If the water temperature is 55-70 F (12-19 C), the anise seeds can be primed for 48-72 hours. Do not prime the seeds in water temperatures below 50 F (9C) or some chilling injury may occur.

The MOST CRITICAL part of seed priming is the drying process. Anise seeds should be dried down to 15 % moisture if they are planted within 10 days of priming, 12 % moisture if they are planted within 11-21 day and 10 % moisture if they are planted after 21 days. The primed seed can be spread thinly over a smooth clean garage or shop floor and raked gently 3-4 times a day for the first few days. The drying process can be speeded up with a fan gently blowing over the surface of the seeds.

Priming and drying can be done in batches, depending on the available equipment, as long as the moisture content of the seed is monitored during drying, as noted above. Each anise producer must modify this procedure as best fits his or her circumstances.

Summary:

Priming anise seed in aerated water at room temperature for 24-36 hours will increase percentage emergence and stand density, especially in years with drought stress between planting and stand establishment. This will produce an anise crop that matures more uniformly, resulting in higher quality anise seed. In certain years, seed yield of anise may also be increased.

NOTE 1: You now know how to produce high quality anise seed, but are you willing to go to this much fuss and bother?

NOTE 2: Who thought that their grandmother or great-grandmother didn't know what she was doing when she soaked her carrot, parsnip and other seeds before planting them? We now know that aeration is a critical part of the process (she probably knew that also, but she didn't tell us).

4. Dill (*Anethum graveolens* L.)

Breeding Studies:

Seed of two lines of dill was planted in the spring of mid-May 1997 and increased again in 1998. At harvest, 100 plants of each line were selected and increased in miniplots in 1999. Selected lines were increased further in miniplots in 2000. The best lines of each population were planted in isolation in replicated yield trials in 2001. Seed of the best lines within the better population will be bulked as pre-Breeder seed to produce Breeder seed of this new variety in 2002. Quality data are not available at this time, but will be used to determine which lines go into the pre-Breeder seed.

Dormant Planting: Two lines of dill were dormant planted (in late October) in 1997, 1998, 1999, and 2000. However, seed was harvested in only 3 of 5 tests, suggesting that this would be a borderline practice with dill in Saskatchewan. However, an alternative practice may be priming the seed (see priming under anise).

5. Ajowan (*Carum copticum* L.)

Research on ajowan was discontinued because of its late maturity, small seed size and resulting difficulty in getting a stand established in dry springs. One other finding is that the crop is very late maturing and does not thresh out easily unless the umbels are completely dry. This means that the crop must be swathed prior to combining.

6. Fenugreek (*Trigonella foenum-graecum* L.)

Research on the fenugreek project will be reported in the fenugreek report. Breeder seed of two new varieties of fenugreek will be produced in 2002.

RESULTS AND CONCLUSIONS

Research on this project over the past 5 years has resulted in the following:

1. Dormant planting (late October planting) of coriander can now be recommended as an alternative to spring planting in Saskatchewan.
2. Dormant planting (late October) planting cannot be recommended for annual caraway, anise, biennial caraway, or ajowan in Saskatchewan.
3. Dormant planting (late October) planting of dill has been successful about half the time, suggesting that it might be feasible in parts of the prairies with warmer winters and springs than at Saskatoon.
4. Priming of the seeds of the Apiaceae (carrot) family by soaking them in aerated water at room temperature for 24 to 36 hours and then drying them back to ambient seed moisture levels before planting results in a denser stand (higher percentage emergence) and a more uniform maturing stand. Both of these factors contribute to higher quality seed of these crops. The results on anise were extrapolated to other members of the carrot family.
5. CDC Minor, a small-seeded coriander variety with a high percentage essential oil, was released in the fall of 1999 and enough pedigreed seed has been produced to plant at least 15% of the anticipated acreage of coriander in Saskatchewan in 2002.
6. CDC Major, a medium large-seeded coriander variety with high seed yield, was released in 1999 and enough pedigreed seed has been produced to plant at least 10 %of the anticipated acreage of coriander in Saskatchewan in 2002.
7. Seed of selected lines from an old variety of dill will be bulked in the spring of 2002 to produce Breeder seed of an improved variety in the fall.
8. In coriander, and presumably in other members of the Apiaceae (carrot family), percentage essential oil (and its major component, linalool); and percentage fixed oil and its major component, petroselinic acid) are traits of medium high heritability. Thus, they can be successfully selected on the basis of a single non-replicated progeny test, provided the breeder goes back to remnant seed of the original selected plants and increases them in a completely isolated plot.
9. In coriander, and presumably in other members of the Apiaceae (carrot family), plant height, days to flower and days to mature are highly heritable traits. Thus, provided genetic variability for these traits is present, selection for these traits will be successful if the breeder goes back to remnant seed of the original selected plants and increases them in a completely isolated plot.
10. These members of the Apiaceae are cross-pollinated and readily intercross within a given species. These results emphasize the importance of eliminating pollination by an unselected plant. Thus, it is important to always go back to remnant seed of the progenies selected for a specific trait and let them intercross in complete isolation from any other plants of that species.

Personnel – Several summer students, Lori Jackson (Lab technician) and Abdulghasem Bahrani (Research Assistant).

Equipment – None purchased.

Publications-

Bandara M. S. and A. E. Slinkard. 2002? Fruit Priming Accelerates and Synchronizes Crop Maturity in Anise (*Pimpinella anisum* L. (In manuscript for J. Herbs, Spices & Med. Plants)

Bandara, M. and A. Slinkard. 2002. Improving Quality of Anise Seeds. Saskatchewan Herb and Spice Association Spring Newsletter.

McVicar, R., P. Pearce, K. Panchuk, S. Hartley, C. Brenzil, A. E. Slinkard and F. A. Holm. 2000. Coriander in Saskatchewan. Saskatchewan Agriculture and Food, Regina. Farm Facts.

McVicar, R., P. Pearce, K. Panchuk, S. Hartley, C. Brenzil, A. E. Slinkard and F. A. Holm. 2000. Caraway in Saskatchewan. Saskatchewan Agriculture and Food, Regina. Farm Facts.

Arganosa, G.C., Sosulski, F.W. and Slinkard, A. E. 1998. Seed yields and essential oil of northern-grown coriander (*Coriandrum sativum* L.). J. Herbs, Spices & Medicinal Plants 6(2): 23-32.

Slinkard, A. E. 2002. Production of New Coriander Varieties. Saskatchewan Herb and Spice Association Annual Meeting (oral report).

Photos – None.

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Project Public Information –

1. Release of Breeder seed of CDC Major medium large-seeded coriander with high seed yield in 1999.
2. Release of CDC Minor small-seeded coriander with a high percentage essential oil in 1999
3. Production and release of Breeder seed of a high yielding variety of dill in 2002.

Deliverables – Breeder seed of CDC Major and CDC Minor coriander and dill (in 2002). Also, the practice of dormant seeding of coriander.